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Automating the Incoming Materials Process Contributes to Implementing Industry 4.0

by Robert J Black Jr

Introduction

With the growing interest in industry 4.0, many OEM and EMS electronics equipment manufacturers are making steady progress towards the goals of “smart factories” and “lights out manufacturing”. One of the key requirements for achieving these goals is a comprehensive database of all materials, processes, and procedures necessary to manufacture these products. Many companies have several software systems which must work together to successfully achieve their manufacturing goals.

While most companies use an ERP (enterprise resource planning) system to help manage the business, they may in addition be using an MES system (manufacturing execution software) on the factory floor. In addition, the many pieces of equipment used in the manufacturing lines may have their own operating software, maintenance software, individual machine controllers, and line controllers. The integration and management of these systems is a challenging task. Perhaps the first important requirement to achieving this integration is to have accurate and complete data in the database of materials, processes and procedures. In this paper we address the first requirement to have complete and accurate information on the materials used to manufacture these products, specifically the electronic components.

Electronic Components

The data collected on electronic components includes; component part number, manufacturer's lot number, date code, and possibly an internal reference number. Since currently, the majority of components are surface mount, most of them are packaged in pocketed tape delivered in reels. Though some components can come in tubes, Jedec trays, or boxes. When these parts are received, the traditional procedure is to enter the component part number and quantity manually, which can lead to errors in the data entry process. Many of the components are packaged with barcode labels and in that case the receiving process can include reading by a barcode scanner to automatically enter the component data. There is a problem that can arise during this procedure caused by the fact that many component reels or boxes may contain multiple barcodes. These can be a manufacturers barcode, a Distributors barcode, a forwarders barcode, and the customers barcode if the part is being consigned to an EMS company. With several barcodes to choose from, which barcode should the receiving person scan? Which barcode contains the correct data needed for the manufacturing process? Any confusion in answering these questions can result in wrong data being supplied to the inventory and the manufacturing process, which could result in the wrong component being supplied to the line.

Unique ID

Another requirement for automated manufacturing, and complete traceability, is that each component reel, tube, tray, or box have a unique ID. For example, a company may receive 20 reels containing 5000 300mfd capacitors each. But even though they are on different reels these parts all have the same part number and may have been manufactured in the same lot. To be able to track each reel accurately in inventory and through the production process the individual reel must be identifiable from the other 19 reels of the same component. Some ERP and MES systems already use the unique ID concept, and assign a unique ID for each reel during the receiving process. But many companies have older ERP software and still do not use a unique ID in their inventory control system.

Incoming Material Station

Recently the development of the incoming material station has addressed many of the issues we have discussed above. The station takes the form of a large desk with an ESD surface and a large window located in the center. Below this window is a High Resolution Camera and a sophisticated lighting system. Underneath the table, there are storage facilities to hold component carrier trays if automated component storage systems are in use by the factory. To receive the material, the operator simply places the component reel, tube, tray, or box on the window with the barcodes facing down. The camera will scan all barcodes, analyze them, data mine the correct information needed by manufacturing, and automatically print a unique ID label. The operator then applies this label to the component reel and the receiving process is complete. The unique ID is generated by communication with ERP system if a unique ID system is already in use. If the company does not yet use unique IDs, the material station will automatically generate a unique ID for the component and inform the ERP and MES systems of that ID.

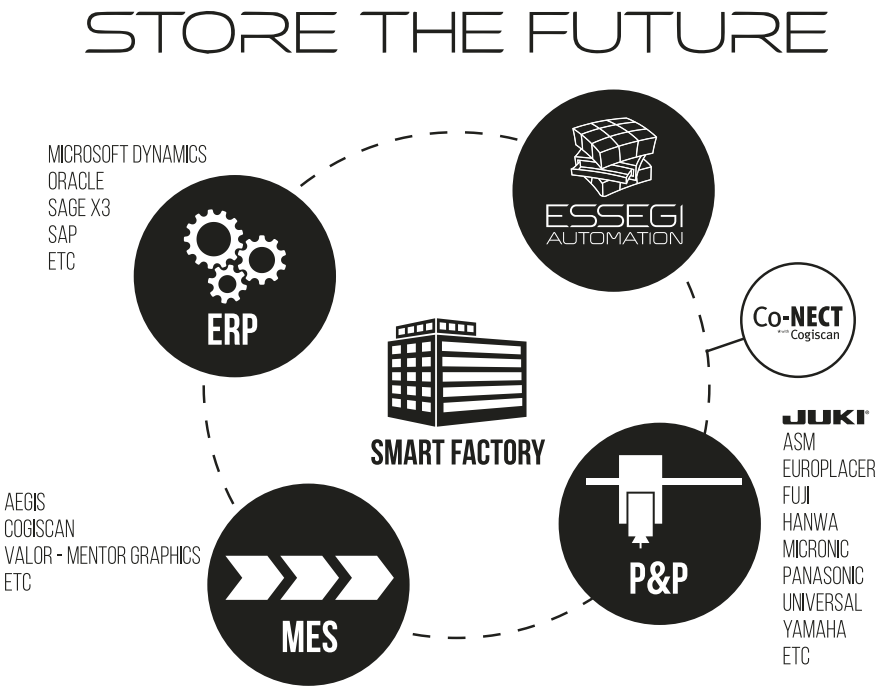
The camera and software are able to recognize, parse, and store any 1D or 2D code found on the component. The software is set with standard rules used by most component suppliers to label their products with available fields of; part number, case format, quantity, bin number, date code, MSL, manufacturers part number, lot number, expiring date, supplier order reference, a notes field, and even custom fields. Any nonstandard label can be easily read by setting customized rules as long as the codes contain a recognizable indicator. The software includes subroutines which can identify even degraded barcodes. An exciting new feature included with the station is “Reels Picture Traceability”.

An image of each component and barcodes is stored in the database and is available for future recall for visualization and quality checking. This tool brings traceability to an even higher level and it can also provide evidence of damaged or mislabeled material coming from suppliers.

The incoming material station allows one operator to process many times the number of components that a manual entry or barcode scan can process. Field experience shows that a single station can handle the workload of 4 to 5 individuals doing manual entry receiving. This results in significant savings in labor costs, but also updates the available inventory information much faster making it available to both planning and manufacturing. If the company uses approved parts list, a new software option allows the station to check the received part against the list and if it does not find the part number listed as an approved component it will not receive the reel and will warn the operator the part is not approved. In addition, the packing list/delivery note checking module option will automatically check the quantities and part numbers against a supplied packing list to make sure all material stated has arrived and to recognize any excess or incorrect material. This option includes the installation of a second monitor where the delivery note information is shown as the checking process is confirmed.

Interfacing

The incoming material station can be connected with other systems such as ERP, MES, pick and place lines, etc. Thanks to the API interface, any software can communicate and receive information from the incoming material station and automatic filesharing with other software is also possible. The result of these connections, is that all company systems are updated as to inventory availability immediately, allowing for a more efficient and timely production cycle. Also, all information necessary for the automatic generation of traceability reports is automatically transmitted to both ERP and MES systems.

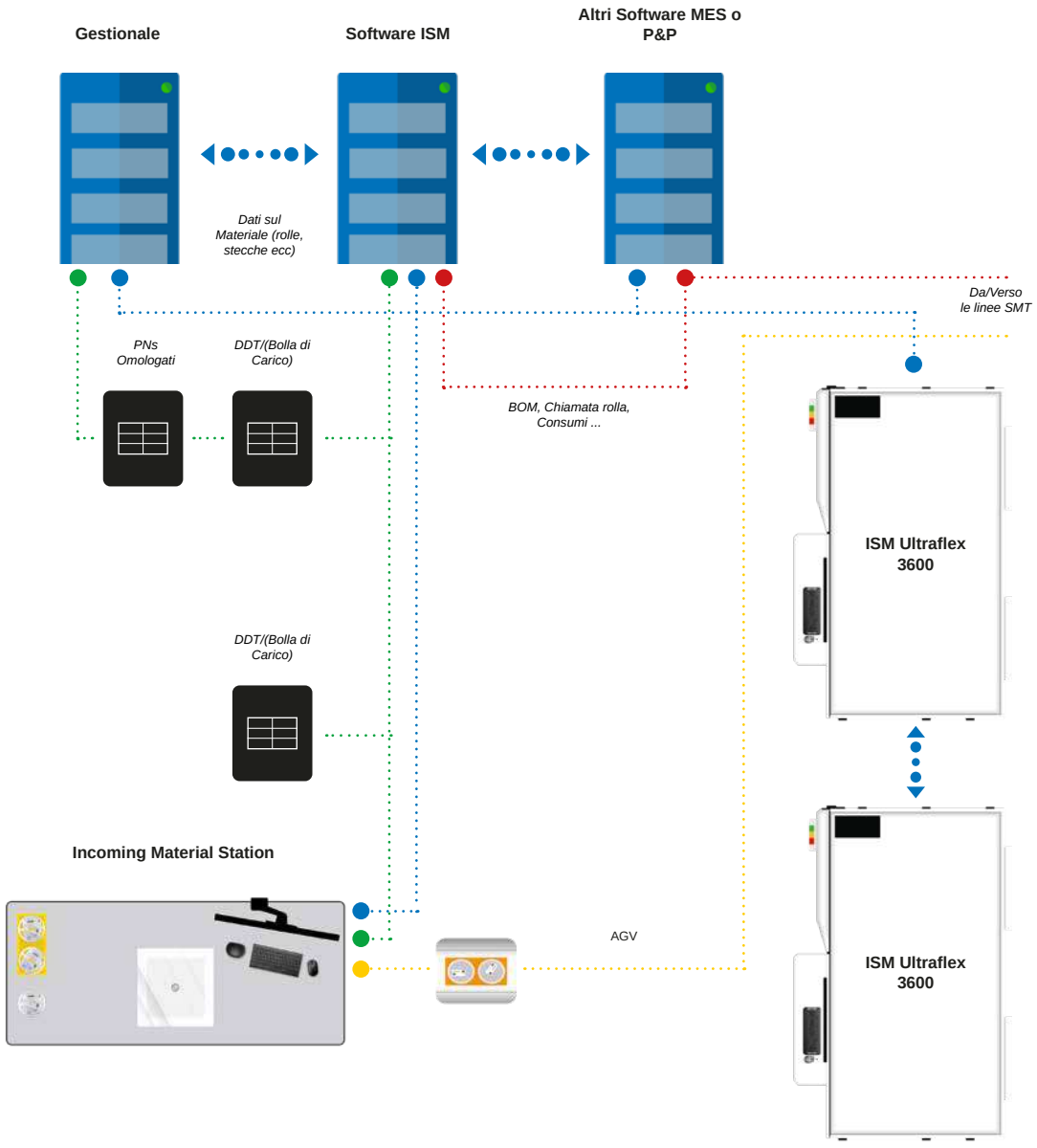


Component Storage and Kit Preparation

A recent development on the logistic side of manufacturing is the availability of automated component storage and retrieval systems. These systems can automatically store thousands of component reels, trays, and tubes, along with the quantities and all other data available on these components. Many of these systems also feature humidity control and automatic tracking of the MSL status of sensitive parts. When a component leaves the storage system, software automatically tracks the time the component is outside the humidity-controlled environment, and warns when the eligibility time of this component is about to expire. Perhaps the best feature of many of these systems is that they can pull kits upon request of the ERP or MES systems. This results in faster kitting times, more accurate component delivery, and greatly reduced labor costs. Another valuable feature of the automated component storage system is that it can communicate directly with the pick and place lines. If a pick and place machine sends a warning that a component is running low and additional quantities are required, the storage system can interrupt its current task, pull an additional reel of the component which is about to run out, and have that real arrive at the appropriate placement machine before the component runs out thus avoiding expensive downtime. The incoming material station makes a great partner for the component storage system by furnishing all the necessary data to the sever as part of the receiving process.

Towards the Automated Factory

We can see below a diagram illustrating the developments we have discussed in the previous paragraphs. A completely integrated receiving, storing, tracking, and pulling system to provide seamless supply of components and other materials to the manufacturing production lines. As more companies seek to improve the efficiency, reduce costs, improve quality, and maintain continuous control of manufacturing operations, systems like these will be valuable building blocks to achieving these goals.



- **To review the points above, an incoming material station can;**
- **Avoid mistakes in data entry**
- **Speed the receiving of materials**
- **Lower labor costs**
- **Provide correct and timely information to the ERP and MES systems**
- **Communicate seamlessly with automated component storage and retrieval systems**
- **Be a valuable building block in the journey towards an automated factory**

ESSEGI AUTOMATION | Storagesolutions.it® division

Headquarters
Via della Tecnica, 33 36050 SOVIZZO ITALY

Offices
Via Risorgimento, 71 -36051 SOVVIZZO – ITALY

Warehouse
Via della Tecnica, 33 - 36050 SOVIZZO – ITALY

Tel. 0444 376380 | info@storagesolutions.it

www.storagesolutions.it